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D. K. WRIGHT

METHOD OF AND APPARATUS FOR FORMING FILAMENTS

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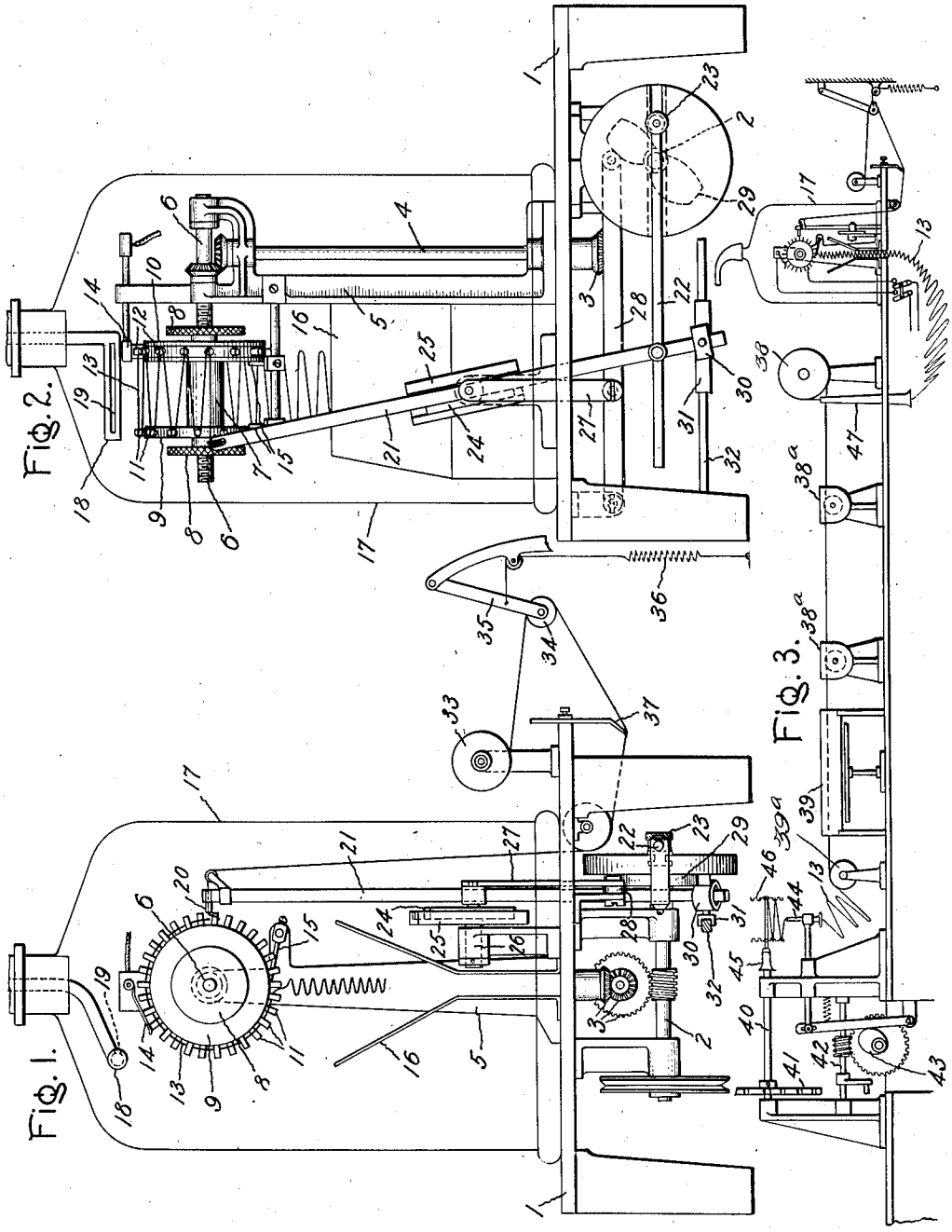

Fig. 2.

Fig. 1.

Fig. 3.

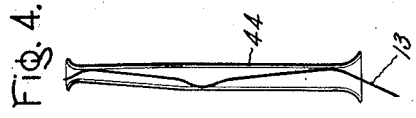

Fig. 4.

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UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR FORMING FILAMENTS.

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In the manufacture of incandescent electric lamps having metal filaments, particularly filaments of tungsten, the filament may to advantage be bent or set in a sinuous or zigzag form to facilitate mounting it on the metal hooks or anchors of the mount.

The object of my invention is to provide an improved method and apparatus for shaping wire, particularly resilient tungsten wire, into a sinuous or zigzag form suitable for lamp filaments. Another object is to make the shaping of the wire a continuous operation which can be carried on without interruption as long as the wire is unbroken. A further object is to provide an improved method and apparatus for mounting the shaped filament upon the anchors of the mount. To these ends I pass the wire through a shaping device which bends and shapes it into the desired form and discharges it permanently shaped for use as a filament. Only a short length of wire is in the shaping device at a time, and the loops are permanently set while in the device so that they retain their shape and size when discharged from the shaper. As fast as the straight wire feeds into the shaper the formed and set wire is discharged, so that the shaper can be run continuously as long as wire is supplied to it. The wire may be of any length desired and I prefer to have it as long as practical so that the operation of shaping it may be continued for long periods without interruption.

The novel features of my invention are pointed out with particularity in the appended claims, and merely for purposes of illustration I have shown in the accompanying drawing some of the various forms in which it may be embodied. In the drawings, Figure 1 is a side view of one form of embodiment of my invention; Fig. 2 an end view of the device shown in Fig. 1; Fig. 3 a side view, partly diagrammatic, of a mechanism for automatically winding the filament on the mount of the lamp, and comprising the device shown in Fig. 1 for forming the wire, mechanism for coating the formed wire, and means for automatically winding the formed wire on the mount after it has been coated; and Fig. 4 is a longitudinal section of a tension device for the formed filament.

In the particular form of device shown in the drawings, a frame 1 in the form of a table carries the various parts of the machine. On this frame, and preferably beneath the top of the table, is mounted the driving mechanism. Part of this mechanism is the drive shaft 2 connected through gearing 3 to the lower end of a countershaft 4 mounted in a standard 5 on the top of the table. The countershaft 4 is geared at its upper end to a horizontal shaft 6 suitably journaled on the standard 5.

The wire which passes through the particular form of shaping device shown is given a sinuous or zigzag form by being stretched or wound back and forth on a shaper or former which travels in an endless path, receiving the straight wire at one point in its path, and discharging the formed wire at another point. In the particular arrangement shown this shaper is rotatable and is mounted on the shaft 6. I prefer to make it adjustable so as to vary the size of the loops formed on it. To this end I provide a loose sleeve, such as 7, to slip over the shaft 6. Binding nuts 8 threaded on the shaft clamp two disks 9 and 10 solidly against the ends of the sleeve 7. Each disk is provided on its periphery with an endless row of radially projecting metal pins 11 and 12, which are preferably made of some metal, such as copper, which does not become covered with an insulating oxide. By using sleeves 7 of different lengths the distance between disks can be changed, and thereby the length of the loops formed in the filament can be changed as desired.

The pins 11 in one row are connected to the metal of their disk 9, but the pins 12 in the other row are insulated from their disk in some suitable way as, for example, by being set in insulation, such as fibre. As best shown in Fig. 2, the wire 13 is stretched back and forth from one row of pins to the other in the sinuous or zigzag form shown by means which will be described later. As the shaper rotates in a counter-clockwise direction the pins 12 are carried one after another into engagement with a brush 14 connected to one terminal of a suitable source of current, the other terminal of which is connected to some metal part of the machine and therefore to the pins 11. As each pin 12 comes into contact with the brush 14, current flows from that pin through the stretched wire 13 to one or more of the pins 11. This current is so ad-

justed that the straight part of the wire between the rows of pins is raised to incandescence, although the bends of the filament which are in contact with the pins, are not appreciably heated. As a result the filament is set in the shape given it on the shaper. Tungsten wire as commonly made is very stiff and resilient, and if bent, will spring back to its original form when released. Such wire will not hold its shape if bent around the pins 11 and 12 and then released without heating. By passing current through the wire from a pin 12 to the other pins 11, I render the straight parts of the loops of wire non-resilient, but as the bends are not heated they retain their resiliency and stiffness, and keep the filament in the shape given it on the shaper. As the bent and set wire is carried on by the travel of the shaper, it is eventually stripped off the pins and released by some suitable stripping or discharge device, such as the stripping fingers 15 which are set at a tangent to the path of the pins and strip the wire off the pins as the pins pass them. The shaped wire is discharged into a chute 16 and passes down through a suitable opening in the table 1.

To protect the tungsten wire when it is incandescent, I heat or flash it in an inert atmosphere of hydrogen or nitrogen or a mixture of them known as forming gas. For this purpose I cover the shaper with a bell or cover 17, preferably of glass. The cover may be raised and lowered by any convenient means. Forming gas is supplied to the cover, and any excess escapes at the lower edge of the cover. To supply the gas directly to the incandescent part of the wire, I may provide for the incoming gas a distributer comprising a pipe 18, having a slot 19 in one side to direct the gas over the wire. This is particularly advantageous when there is some air in the bell, as the stream of gas keeps the air away from the incandescent wire.

The wire is automatically bent around the pins 11 and 12 and stretched from one row of pins to the other by a cooperating member driven in synchronism with the shaper. In the particular arrangement shown in the drawing this mechanism comprises a wire guide 20 preferably in the form of a tube of hard metal, through which the wire feeds. This wire guide is mounted to move back and forth longitudinally of the shaper and stretch the wire from one row of pins to the other, having sufficient travel to pass through both rows of pins and being so synchronized with the shaper that when the guide is outside either row of pins the shaper and guide move relatively to each other sufficiently to carry the wire around the pin and thereby bend the wire about that pin when the guide moves back toward the other row of pins. For example, the guide may be given a reciprocating motion, and the shaper rotated step by step so that it moves while the guide is practically stationary at each end of its path, but I prefer to so arrange the mechanism that the shaper moves continuously and the wire guide has a path which it can follow without jerky movements or very abrupt changes in direction. To this end I mount the wire guide 20 on the upper end of a pivoted arm 21, the lower end of which is oscillated by a connecting rod 22 driven by a crank pin 23 on the driving shaft 2. The crank pin can be adjusted to change its throw to correspond to the distance between the disks 9 and 10 of the shaper. The throw of this crank is such that as the driving shaft rotates, the wire guide 20 oscillates between a point outside one row of pins and a point outside the other row, passing through both rows of pins in its travel.

In order to provide ample clearance between the pins and the wire guide 20, I prefer to cause the wire guide to describe a loop around each pin on the shaper. One way of obtaining the desired movement is to pivot the arm 21 in such a manner that it can be raised and lowered in synchronism with its oscillations about its pivot. As an example of a suitable arrangement I show in the drawing a block 24 which is rigidly attached to and forms part of the arm 21, and which slides in a guide 25 journaled in a bearing 26. The block 24 and the guide 25 both oscillate or rock as the arm 21 oscillates. The block 24 is raised and lowered at the proper times by the driving mechanism through any suitable means, such as a link 27 connected to the block and to a cam follower 28 which engages a double lobed cam 29 in the shape of the figure 8 mounted on the driving shaft. The cam 29 and the crank pin 23 are set in such an angular relation that as the wire guide 20 is moved toward one of the pins of the shaper by the crank pin 23, the block 24 is simultaneously raised by the cam 29 so that the wire guide begins to follow a path which curves about the pin. When the crank pin 23 reaches dead center the wire guide is outside the row of pins. At this time the cam 29 is lowering the block 24, and the wire guide sweeps downward and around the outside of the pin. As the crank pin 23 moves off dead center the wire guide begins to move around under the pin and then begins to rise, due to the combined lifting by the cam 29 and the traversing by the crank pin 23. The wire guide 20 describes a double loop in the form of a figure 8, and the parts are so synchronized that one loop is described about a pin 11, the other about a pin 12, and so on.

To steady the lower end of the arm 21 I may provide for it a guide ring 30 mounted

on trunnions in a guide block 31 which slides back and forth on guides 32 carried by the frame.

The wire is delivered to the wire guide through some suitable tensioning device, which should have very little inertia. I prefer to use the form shown in Fig. 1 in which the wire fed from a spool 33 passes over an idler pulley 34 carried on a very light pivoted arm 35 which is restrained by a long coiled spring 36.

To obtain a properly shaped filament which will keep its shape the stiff resilient tungsten wire should have a tendency to curl into coils of a curvature which just fits the metal pins of the shaper. I treat the wire to give it a tendency when free to form curls which will fit the metal pins snugly. Uncurled wire makes bends which are too sharp or angular, but if the wire is curled too much the sides of the bends overlap when the wire is released from the shaper. A simple and desirable way of imparting to the wire the tendency to curl to the desired extent is to pass it over a curler, such as a bar 37 provided with a rounded edge and mounted on the frame 1 in such a relation to the tension and feeding devices that the wire as it passes to the wire guide 20 is bent at an angle over the rounded edge of the curler. This curler is preferably made adjustable so that it can be set to bend the wire at the proper angle to produce the desired curling.

After the wire is formed it can be cut into filaments by cutting it at selected bends with scissors or pliers, or it can be wound on spools or into a cop, preferably with what is known as the universal winding and cut to length when unwound by the operator. I have found that resilient tungsten wire bent and set as above described can be wound on a spool, or into a cop, and when released or unwound it will spring into the sinuous or zigzag shape given it in the shaping device, as the bends retain their resiliency, and hold the filament in shape.

After the wire has been formed and set it can if desired be coated with some inorganic salt or other material which will improve the lamp. For example, as shown in Fig. 3, the formed wire may be led over a suitable idler pulley 38 to a reservoir 38a containing a grooved wheel which applies to the wire some suitable compound which is then dried on the wire to produce a coating. The coated wire may receive a second coating in a second device 38a and be passed through an oven or heater 39, after which the coated wire can be wound around a driven winding drum 39a or spooled in convenient form and used later whenever desired.

The wire shaped in accordance with my invention is particularly suitable for being wound upon a mount automatically, and I have illustrated in Fig. 3 one form of machine for carrying out this operation. In this machine a rotatable mount holder 40 is intermittently rotated by suitable gearing 41 driven from a drive shaft 42, which also through a cam 43 or suitable mechanism moves or reciprocates a filament guide 44. A lamp mount comprising a stem or flare 45 carrying a glass hub in which the anchors 46 are embedded is placed on the mount holder 40 which fits the stem snugly enough to hold it and to cause the mount to rotate as the holder 40 is rotated. The filament, bent into a sinuous or zigzag form, is fed through the filament guide 44 while the driving mechanism causes such relative movement of the mount holder 40 and of the filament guide 44 that the formed filament is placed on the anchors 46 of the mount with the bends of the filament on the hooks of the anchors. To carry out this operation successfully the tension with which the filament is wound on the anchors must be controlled very exactly, as the anchors are made of very fine wire. In accordance with my invention the desired tension is obtained by so proportioning the bore of the filament guide 44 that as the shaped filament passes through it the resilient bends of the filament are slightly distorted or strained and produce sufficient friction with the filament guide to maintain the desired tension on the filament. I prefer to make the filament guide 44 of glass, as this material gives very good results, but it may, of course, be made of any other suitable material. As the bends of the filaments retain their resiliency or springiness, while the straight parts of the filament between the bends are practically non-resilient, the filament passes through the filament guide 44 as a straight wire with slight projections at the bends of the convolutions. These projections or bends rub against the walls of the filament guide 44 and cause sufficient friction between the filament and the guide to give the desired tension on the filament.

Although I have described the shaper as rotating, and the wire guide 20 as moving longitudinally of the shaper, I do not wish to be restricted to these particular movements, as it is immaterial which member of the shaping device moves so as to carry the wire from one row of pins to the other, or what the absolute movements of said members may be as long as the wire guide and the shaper travel in paths which are in general transverse to each other and their movements are synchronized to bend the wire into the desired shape.

The proper tension may be applied to the shaped wire by passing it through a tube 47 having a straight bore of the proper size. This method of tensioning the shaped filament is advantageous in controlling the pas-

sage of the wire through the treating device.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. The method of shaping a resilient wire into a permanently sinuous form having regularly recurring bends which consists in imparting to said wire a tendency to form curls of a definite curvature, stretching said wire in a zig-zag form over cylindrical metal pins having the same curvature as the curls in the wire and thereby causing said wire to fit said pins snugly at the bends, and passing current through the wire to render the wire between the pins non-resilient.

2. A filament forming machine comprising a movable shaper having two parallel rows of parallel projections, a movable wire guide, driving mechanism for producing relative movement of said shaper and guide to cause said guide to move from one row of projections to the other and also to move along and outside of one row in one direction and along and outside of the other row in the opposite direction to stretch a wire on said shaper in zig-zag form, and means for heating each loop of the zig-zag wire in succession and thereby setting the wire permanently while it is stretched on said shaper.

3. A filament forming machine comprising a movable shaper having projecting pins to impart a zig-zag form to a wire stretched on it, a wire guide for stretching a wire on said shaper, driving means for producing continuous relative movement of both said shaper and said guide to cause said guide and each pin to move around each other in a curved path to stretch a wire on said shaper in zig-zag form, and means controlled by said driving mechanism for heating and setting the wire while it is stretched on said shaper.

4. A filament forming machine comprising a shaper mounted to travel and having two parallel rows of projecting pins on which a wire may be wound in zig-zag form, a wire guide movable both transversely to and longitudinally of the line of travel of said shaper, driving mechanism for actuating said shaper and said guide in definite relation to each other to cause said guide to travel in closed curves about each pin to stretch a wire on the shaper in zig-zag form, and means for heating each loop of the zig-zag wire in succession and thereby setting the wire permanently while said wire is stretched on said shaper.

5. A continuous forming machine for metal filaments comprising a plurality of curved metal pins, means for imparting to a wire a tendency to form curls of substantially the same curvature as said pins, relatively movable cooperating members for bending the wire into a plurality of equally spaced uniform bends and bringing each bend into contact with a corresponding one of said pins, and means operated in synchronism with said members for passing an electric current from each pin to the pin in the adjacent bend of the wire through the intervening wire and thereby setting said wire.

6. A filament forming machine comprising a rotatable shaper provided on its rim with radial projections arranged in two circumferential rows, a wire guide mounted to move across the rim of said shaper through both rows of projections and around each projection in a curved path, driving mechanism for rotating said shaper and moving said wire guide to and fro and around each projection to bend a wire around a projection in one row and then in the other alternately and thereby stretch the wire on said shaper in a zig-zag form, and means controlled by said driving mechanism for passing current through each loop of the zig-zag in succession while the wire is stretched on the shaper to give said wire a permanent set.

7. A filament forming machine comprising a traveling shaper having a plurality of projecting pins arranged in two parallel rows on its surface, a wire guide mounted to move back and forth across the surface of said shaper and also along the rows of pins, driving means for moving said shaper and said guide relatively to each other to cause said guide to move back and forth and around each pin in succession to stretch the wire from said guide on said pins in a zig-zag form, means encountered by said pins at a point in their travel beyond said guide for causing current to flow through each loop of the wire in succession as it passes a predetermined point, and means cooperating with said shaper at a subsequent point in its travel for automatically stripping said formed filament from the pins.

8. A filament forming machine comprising a rotatable shaper having two rows of radially projecting metal pins extending circumferentially around said shaper, the pins in one row being insulated from those in the other, a movable wire guide mounted to move across the rim of said shaper and around each pin in a curved path to stretch a wire over said pins in a zig-zag form, stripping means mounted adjacent another point of said shaper for engaging and automatically stripping the zig-zag wire off the pins of said shaper, and an electrical contact mounted between said wire guide and said stripper in position to engage each pin of one row in succession and thereby cause current to flow from each pin of said row through the wire to the pins of the other row and thereby permanently set said wire.

9. A filament forming machine comprising a rotatable shaper having two circumferential rows of radially projecting metal pins, the pins in one row being insulated from the

pins in the other row, a wire guide mounted to move in a curve around a pin in one row and then around a pin in the other row to stretch a wire over said pins in zig-zag form, driving mechanism for imparting continuous movement to said shaper and said guide, an electrical contact mounted in position to cooperate with the pins of one row in succession, of means for establishing a difference of potential between the pin in engagement with said contact and a corresponding pin in the other row as said pins reach a predetermined point in the rotation of the shaper.

10. In an apparatus for shaping resilient wire into a sinuous form having convolutions with regularly recurring bends, the combination of a shaping device on which the wire is stretched and having cylindrical pins to form the bends of means for imparting to said wire a tendency to form curls having the same curvature as the surface of said pins.

11. A filament forming machine comprising a travelling shaper having two rows of pins side by side and extending in the direction of travel, a wire guide for feeding a wire into position to be bent around the pins of said shaper, mechanism for causing said guide to travel in a closed path in the form of a figure 8 with the loops encircling corresponding pins in the two rows on said shaper, and a driving mechanism for actuating said shaper and said mechanism to cause the wire to be stretched on the pins of said shaper in zig-zag form.

12. A filament forming machine comprising a travelling shaper having two rows of pins side by side and extending in the direction of travel, a wire guide for feeding a wire into position to be bent around the pins on said shaper, mechanism for causing said guide to move both transversely and longitudinally of the direction of travel, and driving mechanism for actuating said shaper and said mechanism to cause the wire to be stretched on the pins of said shaper in zig-zag form.

13. A filament forming machine comprising a travelling shaper having two rows of pins side by side and extending in the direction of travel, a wire guide for feeding a wire into position to be bent around the pins on said shaper, mechanism for causing said guide to oscillate about its pivot transversely of the direction of travel of the shaper, guiding mechanism for oscillating the pivot of said guide in the direction of travel of said shaper, and common driving mechanism for actuating said shaper and said other mechanisms in synchronism to cause said wire guide to describe loops about the pins of said shaper.

14. A filament forming machine comprising a travelling shaper having two rows of pins side by side and extending in the direction of travel, a wire guide for feeding a wire into position to be bent around the pins on said shaper, a pivoted arm which carries said wire guide, a driving shaft, a crank on said shaft connected to said arm to oscillate it longitudinally about its pivot, and a cam on said shaft for raising and lowering said pivot as said wire guide oscillates.

In witness whereof, I have hereunto set my hand this 25th day of January, 1917.

DANIEL K. WRIGHT.